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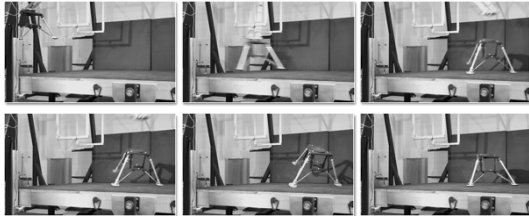
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Structures - Lander Stability

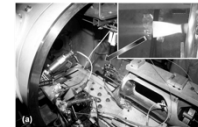
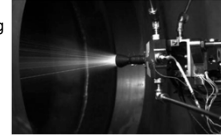
- + Analysis capability to accurately predict the dynamics of touchdown in a stable manner, given a variety of landing scenarios
- + 3-D simulation and testing of a subscale lander with rigid- and energy-absorbing legs completed to anchor ADAMS models to test results



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Propulsion – DACS Thruster Tests

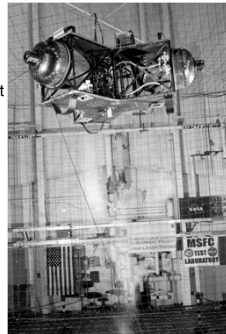
- + For small landers, DACS thrusters used for primary landing propulsion
- + DACS thrusters have not operated for long durations; limited performance data is available
- + Conducted vacuum tests of MDA DACS thrusters for landing (100 lb) and ACS (6 lb) to evaluate performance and thermal characteristics
- + Thrusters successfully demonstrated RLL flight profile (also continuous 66 sec on landing thrusters, 25 sec on ACS)
 - Combustion was stable in all tests
 - Temperature measurements show performance below material thermal limit
 - Remaining modifications and tests have been identified



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Cold Gas Test Article Overview

- + First Flight September 2009
- + Mass: 107 kg dry / 146 kg wet
- + Approximately 10s of flight time
- + Compressed-air propulsion emulates flight system with pulsed operation
 - 3 Descent thrusters (~37lbf ea)
 - 6 ACS thrusters (~12lbf ea)
 - Central throttleable thruster offsets gravity
 - 3 compressed air tanks (3000 psi)
- + Carbon fiber / Al honeycomb decks
- + Custom avionics (COTS components assembled in-house)
- + Custom flight and ground software
- + Over 150 successful flights



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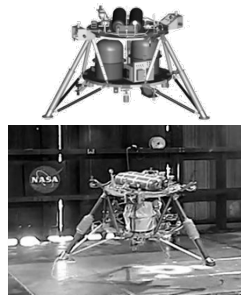
Cold Gas Test Article Flights



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Warm Gas Test Article Overview

- + Strap-down and hover tests complete, expected drop test in summer 2011
- + Mass: 206 kg dry / 322 kg wet
- + Aluminum ortho-grid decks
- + Hydrogen peroxide (90%) monopropellant propulsion system
 - Emulates flight system / pulsed operation
 - 3 Descent thrusters
 - 12 ACS thrusters
 - Central throttleable thruster offsets gravity
- + Sensors
 - LN200-1 IMU, Roke Manor Radar Altimeter, Illunis optical cameras, Novatel Pro-Pak GPS truth data system, Pressure transducers & thermocouples for housekeeping
- + Flight-like Software
 - "In-Control" ground system software
 - Core Flight Executive (cFE) modular software environment



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Warm Gas Test Article Hover Test



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Summary – NASA Robotic Lander Project

- The NASA Robotic Lander Project (RLLDP) team has developed lander concepts encompassing a range of mission types and payloads for science, exploration, and technology demonstration missions.
- The RLLDP team has completed a series of studies to assess the feasibility of various lander architectures.
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- Mature small and medium lander designs have been developed
 - Share largely a common design architecture
 - Flexible for a large number of mission and payload options
- High risk development areas have been successfully addressed
- Landers could be selected for a mission with much of the concept development phase work already completed

The RLLDP project is well prepared to develop lander systems for lunar or other airless body NASA missions

